

Key

Chapter 14 Review

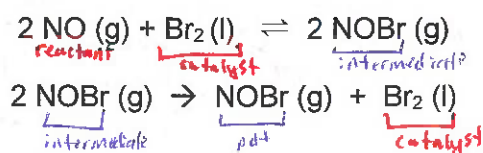
1) For the following reaction, provide the missing data:



Order with respect to: H_2 (second) O_2 (first) H_2O (zero)
 $\rightarrow$ not in rate law

Rate law: $\text{rate} = k [\text{H}_2]^2 [\text{O}_2]$ Overall order: third (3)
 $\rightarrow$ sum of individual rxn orders

2) The mechanism for the bromination of NO involves the following elementary steps:



a) Br_2 is a catalyst NOBr is an intermediate & a product
 $\rightarrow$ there @ start & end
 NO is a reactant
 $\rightarrow$ consumed (start w/), formed & then consumed

b) What is the molecularity of each elementary step?
 $\rightarrow$ # reactant molecules
 ① 2 NO & 1 Br_2 so termolecular or tri molecular
 ② 2 NOBr so bi molecular
 $\rightarrow$ so coefficients are the rxn order

c) What is the rate law for the second elementary step?

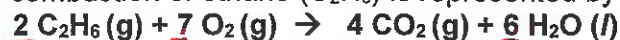
$$\text{rate} = k [\text{reactant}]^m [\text{reactant}]^n \dots \quad \text{rate} = k [\text{NOBr}]^2 \quad \text{Note: This could not be the overall rxn rate law b/c NOBr is an intermediate}$$

d) What is the K_c expression for the first step?
 $K_c = \frac{[\text{products}]_{eq}}{[\text{reactants}]_{eq}}$
 $K_c = \frac{[\text{NOBr}]^2}{[\text{NO}]^2}$
 $\times$ Not pure (s) or (l)
 $\text{Br}_2(\text{l})$ so not included

e) What are the average rate expressions for the second step?

$$\text{ave. rate} = -\frac{1}{2} \frac{\Delta [\text{NOBr}]}{\Delta t} = +\frac{\Delta [\text{NOBr}]}{\Delta t} = +\frac{\Delta [\text{Br}_2]}{\Delta t}$$

$\rightarrow$ reactant so disappearing
 $\rightarrow$ don't write b/c redundant usually don't write b/c redundant

3) The combustion of ethane (C_2H_6) is represented by the equation:

In this reaction:

a) the rate of consumption of ethane is seven times faster than the rate of consumption of oxygen.
 $\frac{\Delta [\text{C}_2\text{H}_6]}{\Delta t} = -\frac{2}{7} \frac{\Delta [\text{O}_2]}{\Delta t}$ b) the rate of formation of CO_2 equals the rate of formation of water.
 $4 \text{ vs. } 6 \therefore \text{No!}$ c) water is formed at a rate equal to two-thirds the rate of formation of CO_2 .
 $\frac{\Delta [\text{H}_2\text{O}]}{\Delta t} = \frac{6}{4} \frac{\Delta [\text{CO}_2]}{\Delta t}$ d) the rate of consumption of oxygen equals the rate of consumption of water.
 $6 \text{ vs. } 7 \therefore \text{No!}$ e) CO_2 is formed twice as fast as ethane is consumed.

$$\frac{\Delta [\text{CO}_2]}{\Delta t} = -\frac{4}{2} \frac{\Delta [\text{C}_2\text{H}_6]}{\Delta t}$$

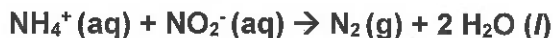
Yes!

Key

4) For a reaction $2A + B \rightarrow 2C$, with the rate equation: $\text{Rate} = k[A]^2[B]^1$ ≈ 3 overall

- a) the order with respect to A is 1 and the order overall is 1.
- b) the order with respect to A is 2 and the order overall is 2.
- ☒ c) the order with respect to A is 2 and the order overall is 3.
- d) the order with respect to B is 2 and the order overall is 2.
- e) the order with respect to B is 2 and the order overall is 3.

5) Given the following data for this reaction:

EXPT [NH₄⁺] [NO₂⁻] RATE

1	0.010 M	0.020 M	0.020 M/s
2	0.015 M	0.020 M	0.030 M/s
3	0.010 M	0.010 M	0.005 M/s

so $[\text{NH}_4^+]^1$ w/c $(1.5)^2 = 1.5$

$2^x = 4$ $x = 2$ so $[\text{NO}_2^-]^2$

rate = $k[\text{NH}_4^+][\text{NO}_2^-]^2$

The rate law for the reaction is:

- a) $\text{Rate} = k[\text{NH}_4^+][\text{NO}_2^-]$
- b) $\text{Rate} = k[\text{NH}_4^+]^2[\text{NO}_2^-]^2$
- c) $\text{Rate} = k[\text{NH}_4^+]^2[\text{NO}_2^-]$
- ☒ d) $\text{Rate} = k[\text{NH}_4^+][\text{NO}_2^-]^2$ ✓
- e) none of the above

6) What are the units of k for the rate law: $\text{Rate} = k[A][B]^2$, when the concentration unit is mol/L?

- a) s⁻¹
- b) s
- c) L mol⁻¹ s⁻¹
- ☒ d) L² mol⁻² s⁻¹
- e) L² s² mol⁻²

$$\frac{\text{mol}}{\text{s} \cdot \text{L}} = k \left(\frac{\text{mol}}{\text{L}} \right) \left(\frac{\text{mol}}{\text{L}} \right)^2$$

$$\frac{\text{mol}}{\text{s}} = \frac{1}{\text{s} \cdot \text{L}} \cdot \text{mol} \cdot \text{mol}^2$$

need to cancel so mol^{-2} so $\frac{\text{L}^2}{\text{s} \cdot \text{mol}^2} = \text{L}^2 \cdot \text{s}^{-1} \cdot \text{mol}^{-2}$

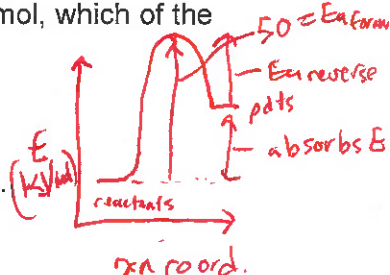
7) Given: $A + 3B \rightarrow 2C + D$ This reaction is first order with respect to reactant A and second order with respect to reactant B. If the concentration of A is doubled and the concentration of B is halved, the rate of the reaction would _____ by a factor of _____.

- a) increase, 2
- ☒ b) decrease, 2
- c) increase, 4
- d) decrease, 4
- e) not change

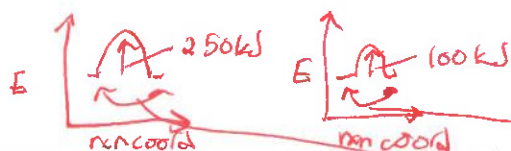
rate = $k[A][B]^2$
 $= k(2)(1/2)^2 = k(0.5)$
 halved or ↓ by a factor of 2

8) Given that a reaction absorbs energy and has an activation energy of 50 kJ/mol, which of the following statements are correct? (Hint: Draw the potential energy diagram.)

- (1) The reverse reaction has an activation energy equal to 50 kJ/mol. **X**
- true** (2) The reverse reaction has an activation energy less than 50 kJ/mol.
- (3) The reverse reaction has an activation energy greater than 50 kJ/mol. **X**
- (4) The change in internal energy is less than zero. **X**
- true** (5) The change in internal energy is greater than zero.



- a) (1) and (4)
- b) (2) and (4)
- c) (3) and (4)
- ☒ d) (2) and (5)
- e) (3) and (5)



9) If reaction A has an activation energy of 250 kJ and reaction B has an activation energy of 100 kJ, which of the following statements **must** be correct?

a) If reaction A is exothermic and reaction B is endothermic then reaction A is favored kinetically.

b) At the same temperature the rate of reaction B is greater than the rate of reaction A.

c) The energy of reaction A must be greater than the energy of reaction B.

d) The energy of reaction B must be greater than the energy of reaction A.

e) The rate of reaction A at 25 °C equals the rate of reaction B at 100 °C.

10) If the activation energy in the forward direction of an elementary step is 52 kJ and the activation energy in the reverse direction is 74 kJ, what is the energy of reaction ΔE for this step?

a) 22 kJ

b) -22 kJ

c) 52 kJ

d) -52 kJ

e) 126 kJ

11) Suppose the reaction: $A + 2B \rightarrow AB_2$ occurs by the following mechanism:

Step 1 $A + B \rightarrow AB$ slow

Step 2 $AB + B \rightarrow AB_2$ fast

Overall $A + 2B \rightarrow AB_2$

The rate law expression must be Rate = _____.

a) $k[A]$

b) $k[B]$

c) $k[A][B]$

d) $k[B]^2$

e) $k[A][B]^2$

